Bellcomm

955 L'Enfant Plaza North, S.W.
Washington, D. C. 20024

date: November 23, 1971

to: Distribution

from: G. S. Taylor

B71 11025

subject: SPS ΔV Reserves for an Apollo 17 Mission to Littrow -- Case 310

ABSTRACT

Constructing missions to the Littrow site following the Apollo 16 timeline, it was found that Atlantic injection was necessary for sufficient SPS ΔV reserves. With 210-foot antenna coverage at PDI and an approach azimuth of -87°, two missions for each of the three launch months, December 1972, January 1973 and February 1973, have small margins over the required end-of-mission SPS ΔV levels. The T-24 opportunity in January can be added if LM rescue ΔV reserves slightly below 600 fps could be accepted. The T+24 opportunity in February can be added if a change is made in the approach azimuth for that month.

Mission characteristics that differ from Apollo 16 are evening launch times and longer mission durations by approximately 14 hours.

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MEMORANDUM FOR FILE

Introduction

One site in which interest has been shown for the Apollo 17 mission is Littrow (20.2° N, 30.5° E). In order to determine whether Littrow would be a feasible site for a mission in December 1972, January 1973, February 1973, a study was made to discover if certain mission constraints could be satisfied. One of the most basic of these constraints is suitable end-of-mission SPS ΔV reserves. It is desirable to have 500 fps ΔV reserves with a minimum of 250 fps being acceptable. Two additional constraints require a DPS abort capability and a sun elevation at landing in the range of 5°-25°. It is also required that at least 600 fps LM rescue ΔV be available. The Apollo 16 timeline was used for these missions.

To determine the mission parameters that would allow these ground rules to be satisfied, the end-of-mission reserves were allowed to optimize with respect to LM approach azimuth and sun elevation at landing. A list of basic mission characteristics and constraints that affect the SPS ΔV reserves and were applied to these missions is given in Table I.

Results

It has been determined that missions to Littrow in December 1972 are feasible only if Atlantic injection is used (Reference 1). This study of the Littrow missions indicates that in January and February 1973 Atlantic injection is still a requirement for feasibility. One result of the requirement is that the launches would occur in the evening hours.

The optimized results for the Littrow missions with Atlantic injection are presented in Table II. This table presents the date, time of launch, the optimum approach azimuth, sun elevation at landing, end-of-mission ΔV reserve, and launch vehicle sigma (σ) capability. From these data, an estimate for a constant approach azimuth for all missions in the time frame was made. Biasing this estimate toward the values of the earlier dates due to their lower end-of-mission reserves results in an estimate of -87° as the constant approach azimuth. Using this approach azimuth and requiring PDI to start at a time when it can be covered from either Goldstone or Parkes results in the sun elevations at landing and SPS ΔV reserves displayed in Table III. The T-24 mission for January and the T+24 mission for February result in SPS ΔV reserves below minimal values, having 584 fps and 364 fps LM rescue ΔV reserves, respectively.

Summary

If Atlantic injections are used, missions to Littrow using the Apollo 16 timeline are feasible for Apollo 17. Assuming a constant approach azimuth of -87° and requiring PDI coverage from a 210 foot antenna results in two missions having less than minimum LM rescue reserves. The first of these, the T-24 mission for January, could be dropped and still leave two launch dates in the second month. The other mission with low reserves is T+24 in February, the last launch opportunity. Two alternatives to remedy this situation would be to fly with only two opportunities in the last month or fly the last month with an approach azimuth closer to the optimum such as -90°. This last alternative would result in about 300 fps additional reserves for the T+24 opportunity in February

G. S. Taylor

2013-GST-jab

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Attachments

REFERENCES

1. Bass, R. A., and S. C. Wynn, "The Region of the Lunar Surface Accessible during March of 1972 (Apollo 16) and December of 1972 (Apollo 17)," Bellcomm Memorandum for File B71 04057, Case 310, April 29, 1971.

TABLE I

MISSION CHARACTERISTICS AND CONSTRAINTS

I. MISSION CHARACTERISTICS

1. 72° LAUNCH AZIMUTH
2. ATLANTIC INJECTION
3. TLI $\approx$ 3.4 HOURS AFTER LIFTOFF
4. MISSION DURATION BETWEEN 12-13 DAYS FOR T_0, T+24 LAUNCHES AND BETWEEN 13-14 DAYS FOR T-24 LAUNCHES
5. TIME IN LPO FROM LOI TO PDI $\cong$ 24 HRS FOR T_0, T+24 LAUNCHES
   $\cong$ 48 HRS FOR T-24 LAUNCHES
6. LUNAR ORBIT TIMELINE APPROXIMATELY THE SAME AS FOR APOLLO 16
7. STAY TIME 73-74 HOURS
8. TWO DAY POST LM ASCENT ORBITAL SCIENCE
9. END-OF-MISSION ΔV RESERVES BASED ON CONTROL WEIGHTS

II. MISSION CONSTRAINTS

1. SUN ELEVATION AT LANDING IN THE 5° - 25° RANGE
2. DPS ABORT CAPABILITY MUST BE RETAINED
3. MAXIMUM RETURN INCLINATION = 70°
4. END-OF-MISSION SPS ΔV MUST BE GREATER THAN 250 FPS
5. LM RESCUE SPS ΔV RESERVES MUST EXCEED 600 FPS

TABLE II

APOLLO 17 - LITTROW

OPTIMIZED MISSION PARAMETERS

(TWO-DAY ORBITAL SCIENCE, ATLANTIC INJECTION)

DATE	OPPORTUNITY	TIME OF LAUNCH (EST)	LANDING AZIMUTH (DEG)	SUN ELEVATION (DEG)	END-OF-MISSION ΔV RESERVES (FT/SEC)	MISSION DURATION (DAYS)	LAUNCH VEHICLE SIGMA CAPABILITY
12/6/72	T_0	21:36	-87.0	11.7	583	12.7	3.11
12/7/72	T+24	21:48	-87.0	22.6	651	12.8	3.13
1/4/73	T-24	20:06	-86.5	13.2	438	13.8	3.00
1/5/73	T_0	20:18	-89.0	15.0	757	12.8	3.12
1/6/73	T+24	20:24	-91.5	24.9	821	12.9	3.09
2/2/73	T-24	23.36	-89.0	5.3	530	13.9	3.05
2/3/73	T_0	23.42	-92.0	6.9	882	12.9	3.14
2/4/73	T+24	23.54	-92.5	18.7	945	12.9	3.18

TABLE III

APOLLO 17 - LITTROW

MISSION PARAMETERS WITH CONSTANT APPROACH AZIMUTH

(TWO-DAY ORBITAL SCIENCE, ATLANTIC INJECTION)

DATE	OPPORTUNITY	TIME OF LAUNCH (EST)	LANDING AZIMUTH (DEG)	SUN ELEVATION (DEG)	END-OF-MISSION ΔV RESERVES (FT/SEC)	LM RESCUE ΔV RESERVES (FT/SEC)	MISSION DURATION (DAYS)	LAUNCH VEHICLE SIGMA CAPABILITY
12/6/72	T_0	21:36	-87.0	12.7	516	662	12.7	3.16
12/7/72	T+24	21:48	-87.0	20.2	612	726	12.8	2.97
1/4/73	T-24	20:06	-87.0	12.8	437	584	13.8	2.98
1/5/73	T_0	20:10	-87.0	12.9	596	743	12.8	3.00
1/6/73	T+24	20:24	-87.0	24.3	522	695	12.9	3.05
2/2/73	T-24	18:36	-87.0	5.2	516	690	13.9	3.04
2/3/73	T_0	18:42	-87.0	5.0	438	612	12.9	3.03
2/4/73	T+24	18:54	-87.0	15.4	176	364	12.9	2.99

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